REVIEW ARTICLE

Posture and its relationship with falls among older people with low back pain: A systematic review

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Abstract:

Abnormal posture is a common health problem that could lead to fall among older people with low back pain (LBP). Since the incidence of falls among older people is increasing, it is important to identify whether posture abnormality contribute to the risk of falls. This study aimed to determine the posture abnormality that related to falls and to identify the relationship between posture and incidence of falls among older people with LBP. Literature searched was followed PRISMA Guideline. The search included Scopus, PubMed, Clinical Key, PEDro and Google Scholar online databases for studies in English published within 2005 to 2020. McMaster critical appraisal tool was used to assess the quality of the studies. The search retrieved 127 articles however, only 6 were included for review. Five studies showed significant association between posture and falls among older people with LBP while one study was not supported the evidence. Abnormal posture was closely related to falls due to changes in center of gravity that affect postural balance among older people. Thoracic hyperkyphosis, loss of lumbar lordosis, and spino-pelvic alignment seem to contribute to a greater postural instability, and thus to a higher risk of falls in older people with LBP.

Keywords: Abnormal posture, falls, low back pain, older people, risk of falls

1. INTRODUCTION

Recent world population statistics found that in 2019 there were 703 million of older people aged 65 and above that shows the largest number of age population globally [1]. Rising in older people population lead to increasing in non-communicable disease such as musculoskeletal pain especially low back pain that is the most common health problem in older people [2-3]. The study reported that the 1-year prevalence of LBP in community-dwelling seniors approximately between 13% to 50% across the world and 70% from the older people population that suffer from LBP [3]. Aging process can lead to changes in the physiological spinal curvature due to changes in the bones, muscles, and joints [4]. Most of people that suffer from LBP will have postural deviations that cause changes in muscle activity that associated with spinal alignment such as swayback and lordosis [5]. Low back pain is associated with poor postural control and falls [6]. World Health Organization (WHO) reported about 28% to 35% of older people at age 65 and above fall each year globally [7]. Previous study found that several risk factors of falls such as age, gender, postural balance, urinary incontinence and frailty [8-11]. Besides, one study found the risk factors included factors such as gait, balance, disability and medical consumption and comorbid condition [7]. Although posture is less to be considered as risk of falls, several studies investigated the relationship between abnormal posture and falls among older people [4, 12].

Posture defines as the position of a person's body in space, the alignment of body parts in relationship to one another and to the environment at one point in time, and is influenced by each of the body's joints [13]. Spinal deformities involves kyphotic posture and loss of lumbar lordosis are related to falls. This is due to reduced mobility of spine on thoracic kyphosis in flexion and lumbar lordosis in extension that could indicate reduced ability to react to postural sway related to an external force [12]. Meanwhile, loss of lumbar lordosis may lead to anterior deviation of the center of gravity (COG) due to significantly increases forward-bending posture and whole-body inclination thus results in higher risk of falls [12]. Previous study reported 20 to 40% of older adults are having thoracic hyperkyphosis over the worldwide [4]. Hyperkyphosis have flexed posture and forward trunk inclination thus change in the sagittal plane of the vertebral column that lead to a anteriorly projection of the center of gravity line which affecting postural balance [4]. A gap exists in the research area to investigate types of abnormal posture that relates with falls among older people with low back pain. Thus, this systematic review aims to determine the posture abnormalities that related to falls and to identify the relationship between posture and incidence of falls among older people with low back pain.

2. MATERIALS AND METHODS

2.1. Research Strategies

The research strategy was based on the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) statement guideline (Figure 1). The literature search was performed through the following databases: Scopus, PubMed, Clinical Key, Physiotherapy Evidence Database (PEDro) and Google Scholar from 2005 to 2020. After screening the titles, abstract, methodology and intervention, full text versions of potential studies were selected. Each database was searched by using the following keywords: "posture", "abnormal posture", "fall", "risk of fall", "older people", "older population", "low back pain", and "back pain". To combine two or more keywords the Boolean operator was used. Studies on abnormal posture were selected based on the inclusion criteria and studies that unclear and incomplete were excluded. There were 18 articles on abnormal posture were found eligible however only 6 articles were included after studies that not reported on either one of the posture, fall or back pain were excluded. The type of studies included were Randomized Controlled Trial (RCT), Cross sectional study and Case control study. The selected inclusion and exclusion criteria were identified by using population, intervention, comparison and outcomes (PICO) as follows:

Population: Older people age 60 years old and above with experienced of LBP.

Intervention: Any intervention that related to posture measurement such as spinal measurement, kyphosis index measure and radiographic spinal measurements.

Comparison: Not applicable.

Outcome: Any relevant outcome measures such as Oswestry Disability Questionnaires, Rolland Morris Questionnaires, Berg Balance Scale, Functional Reach Test and Timed up and Go test.

2.2. Study Selection

2.2.1. Inclusion criteria

The articles were included when comprised the older people aged 60 years and above, diagnosed with LBP and have abnormal posture such as kyphosis, lordosis, scoliosis and foot deformity. Studies with any intervention that measured fall among the subjects also included. Articles were selected based on the relevance of topic and restricted to the English language identified for review from 2005 to 2020 that available in full text articles.

2.2.2. Exclusion criteria

The articles were excluded when the subject's age below than 60 years old, with neurological disorder and the subjects have previous back surgery. Studies that unclear and incompleted, abstract and keyword did not relate to research topic also excluded.

2.3. Research tools: Critical Appraisal Instruments

This study used McMaster Critical Review Form as the instrument tool for critical appraisal. This tool has good inter-rater reliability reported by previous study [14]. This tool consists of 16 items of methodological quality including the study's purpose, literature review, design, sample, outcomes, intervention, results and conclusion that list the criteria needed for research paper. The score use in this tool state as one or zero. If the research articles meet the guideline criterion it will score as "one" but if not meets the criterion will score as "zero". The total score of McMaster is 16 that divided into five categories which classification as excellent with score 15 to 16, very good; 13 to 14, good; 11 to 12, fair; 9 to 10, and poor; 0 to 8.

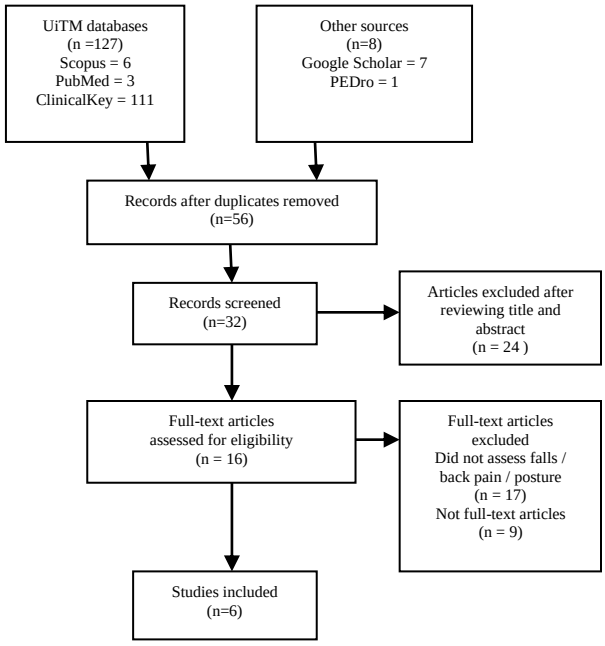

Figure 1: PRISMA flow diagram

2.4. Risk of bias

Cochrane Effective Practice and Organization of Care risk of bias tool was used to assess risks of bias within the study [15]. There were nine criteria for assessment including random sequence generation, allocation concealment, similar baseline outcome, similar baseline characteristic, incomplete outcome data, knowledge of the allocated interventions adequately prevented during the study, protection against contamination, selective outcome reporting and other risk of bias. All criteria were given score of high risk, low risk or unclear.

2.5. Data extraction

Data were extracted based on the study design, sample characteristics, body posture assessment, assessment of balance/ fall risks and results (Table 2).

2.6. Collection, Analysis, and Interpretation of Evidence

Research articles were collected by downloading all available full-text articles from online databases. Articles were then critically appraised by using the McMaster Critical Review form. The McMaster mean score were analysed using SPSS version 22.0 to determine the mean, minimum and maximum scores, standard deviation (SD), and variance between articles.

3. RESULTS AND DISCUSSION

There were six articles found from the literature search where one RCT study, one case control study while the other four were cross sectional study [5,16-20]. By followed the hierarchy level of evidence, one article was at level II while the other five articles was at level IV. In terms of statistical precision, there was four studies showed significant result ($p<0.05$) while the other two studies showed statistical precision ($p <0.001$) and ($p<0.1$). The level of evidence for the reviewed articles showed in Table 1.

Table 1: Trends in evidence

References	Study design	Hierarchy level	Mc Master score	Quality	Statistical precision
Sinaki, Brey, Hughes, Larson, & Kaufman (2005)	Case control study	IV	11/16	Good	$P< 0.05$
Eum et al., (2013)	Cross sectional study	IV	13/16	Very good	$P<0.001$
Young, Je, & Hwa (2015)	Randomized controlled study	II	8/16	Poor	$P< 0.05$
Kim et al., (2017)	Cross sectional study	IV	13/16	Very good	P< 0.05
Chuang et al., (2018)	Cross sectional study	IV	15/16	Excellent	$P<0.1$
Fujita et al., (2019)	Cross sectional study	IV	15/16	Excellent	$P< 0.05$

3.1. Articles supporting the relationship between abnormal posture and falls among older people with LBP

Five articles were included [5,16,18,19,20]. One of them was RCT, one case control study and three cross sectional study. The RCT study showed intervention on posture improved fall efficacy among the older people [18]. While one case control study found that posture program had significantly improved balance, gait and risk of falls [16]. The other three cross sectional studies showed significant result that posture associated with risk of falls among older people [5, 19, 20].

3.2. Articles that did not support the relationship between abnormal posture and falls among older people with LBP

One cross sectional study reported no relationship between kyphosis index measures with balance that could lead to falls [17]. Hence, this study did not support the evidence.

3.3. The Relationship of Postural Abnormalities with Fall among Older People With LBP

Postural deformities such as hyperkyphosis, lordosis, flexed posture, and forward trunk inclination can negatively affect balance that could lead to falls among older people. From the reviewed articles, majority of the research measured thoracic kyphosis [5,16,17,19]. Other than that, spino-pelvic alignment such as pelvic tilt, sacral slope and lumbar lordosis had been included in the research [5,19-20]. Kyphotic posture or hyperkyphosis was commonly seen in aged population that estimated by previous studies to be as high as 40 percent in community-dwelling older people [21]. Increased kyphosis showed to be independently associated with fall risk [22]. The results of radiographic parameter showed that thoracic kyphosis had a propensity to fall [16]. In addition, previous studies reported that the radiological parameters found decreased thoracic kyphosis, decreased lumbar lordosis, decreased sacral inclination, increase pelvic incidence and increase pelvic tilt were identified as significant risk of falls among older people [16]. However, increase kyphosis may be a risk factor for poor mobility and disability that associated with other medical problems included falls, osteoporosis, osteoarthritis and mortality [17]. Kyphotic posture was highly related to falls could be due to flexed posture places the centre of gravity of body closer to the limit of stability [16]. Patients with abnormal spinal sagittal alignment shows higher risk of falls due to its strong relationship with postural instability [19].

Spino-pelvic alignment such as pelvic incidence, sacral slope, pelvic tilt and lumbar lordosis was highly measured by the previous studies [5, 20]. The normal pelvic movement was rotated around the bicoxofemoral axis. However, having poor posture may cause imbalance in spino-pelvic alignment thus result in tension over the facet joints, capsule and ligaments and overuse of stabilizing muscles of the lumbar spine [20]. This problem may affect the postural balance of the older people and lead to fall. Sacral slope was significantly correlated with limits of stability in forward direction and risk of fall [20]. Persons with degenerative lumbar spondylolisthesis that having hyperlordosis presented with high difficulty to maintain postural stability [20].

3.4 The Relationship of Postural Abnormalities and Postural Sway among Older People with LBP

Aging contributes to decrease muscle sensitivity to control body posture that may lead to balance problem among older people [23]. It is known that impaired postural control is one of the intrinsic factors of falls. Spinal inclinations have possibility to relate with postural instability [24]. Postural deformation such as spinal curvature on standing balance is associated to risk of falls among older people due to changes in spatial position of centre of gravity (COG) [25]. Lumbar kyphosis closely affects the spinal inclination and postural balance that contribute to risk of falls among older people [24]. This is because lumbar kyphosis was highly measure of anteroposterior imbalance. Since lumbar mobility was restricted in older people affecting the inhibition of compensation for thoracic kyphosis by the lumbar spine [24]. Thus, this problem may cause higher postural instability associated with lumbar kyphosis.

Table 2: Data extraction

Reference	Study design	Sample characteristics	Posture assessment	Assessment of balance/ fall risks	Conclusion
Sinaki, Brey, Hughes, Larson, & Kaufman (2005)	Case control study	Community-dwelling persons older than 60 years	Radiographic parameter such as lateral radiograph of thoracic and lumbar spine	Quantify postural sway	Balance, gait, and risk of falls improved significantly after a 4-week trial of a spinal WKO and the SPEED program
Eum et al., (2013)	Cross sectional study	Women and men aged 70 years and older	Kyphosis index measure using a flexicurve ruler	Short Physical Performance Battery (SPPB) and Berg Balance Scale (BBS)	Increased kyphosis is significantly associated with measures of physical function, particularly gait speed, chair-time and SPPB score
Young, Je, & Hwa (2015)	Randomized controlled study	-	-	Functional Reach test and TUG test	PIP can induce significant improvements in balance ability and pain for elderly persons with chronic back pain.
Kim et al., (2017)	Cross sectional study	Patients over 70 years of age, who visited an outpatient clinic for back pain treatment	Whole-body radiograph between C7 plumb line and centre of the ankle	History of falls during 12-months of follow up	Whole body sagittal imbalance, measured by the horizontal distance between the C7 plumb line and the centre of the ankle, was significantly associated with risk of falls among elderly patients with back pain
Chuang et al., (2018)	Cross sectional study	Age range 50–80 years, who had LBP and lumbosacral radiographs were enrolled	Full-length spine, spino-pelvic alignment and lumbosacral spine	Fall Risk test by maintaining the dynamic balance	Lordosis was significantly correlated with BMI, back pain disabilities, and stability on an unstable surface
Fujita et al., (2019)	Cross sectional study	Patients aged >65 years	Full-length spine, spino-pelvic alignment and lumbosacral spine	Timed Up and Go (TUG) test and Two-Step test	Patients with age >80 years, lumbar dysfunction, motor deficit of the lower extremities, and forward-bent posture may have a higher risk for falls

There was a significant association between postural deformation and postural control that lead to fall [25]. This could be because of posture deformity such as poor spinal curvature affects the ability to control COG during balance [25]. Therefore, persons with lumbar lordosis and sacral slope may have greater difficulty to maintain the COG and avoid body deviation, thus leading to fall. Back pain is one of the common symptoms that most of older people with kyphotic posture will experienced that induced strain on the ligamentous structure of the spine [16]. They may use less hip strategy or reluctant to make trunk motion due to fear of pain [20]. Therefore, chance of falling may be high among older people with LBP.

3.5. The Importance of Falls and Posture Assessment before Performing Treatment For Older People With LBP

As mentioned earlier, falls commonly occur among older people that become major threat to quality of life (QOL) and restriction in physical and social activities [26]. Based on the findings, abnormal posture and falls are closely related among older people. Good posture declines by age while the risk of fall increases with age [27]. Thus, it is important to assess posture and risk of falls on patient in older age. However, most researchers did not focus on spinal posture and proprioceptive assessment and training among the studies done to prevent falls [16]. This may increase risk of falls among the older people.

There are several posture assessments that widely used by the researchers. From the literature reviewed, most of the studies conducted radiographic parameter such as lateral radiograph of thoracic and lumbar spine [16], whole-body radiograph between C7 plumb line and centre of the ankle [19]., full-length spine, spino-pelvic alignment and lumbosacral spine [5, 20] and kyphosis index measure using a flexicurve ruler [17]. Kyphotic posture had less anteroposterior displacement but higher mediolateral displacement of center of mass that could lead to imbalance between center of mass and base of support [16]. In addition, after assessment of the posture, most of the older people presented with severe kyphosis that cause pushing the head forward [27]. Study also found that decreased lumbar lordosis in older people was significantly associated with risk of falls [19]. This shows that it is important to assess posture prior to any physical management to avoid the risk of falls among older people especially in those with LBP.

A fall assessment is also important to be performed prior to any physical management to determine the level of risk of fall among older people. Fall assessment is closely related to balance assessment as balance instability can lead to fall. In the reviewed articles, fall assessment was one of the outcome measures used in the studies such as monitored history of falls during 12-months of follow up [19], Timed Up and Go (TUG) test and Two-Step test [5], Fall Risk test by maintaining the dynamic balance [20], Functional Reach test and TUG test [18], Computerized Dynamic Posturography that measured to quantify postural sway [16] and Short Physical Performance Battery (SPPB) and Berg Balance Scale (BBS) [17]. Based on the fall assessment, fall risk was measured when the older peoples' proprioception was interfered with the unstable balance platform [20]. In addition, from the Two-Step test score found that older people with age more than 80 years old, lumbar dysfunction, forward-bent posture may have higher risk for falls [5].

From the studies reviewed, it was proved that posture assessment and fall assessment tests are important to determine the risk of falls among older people. This is because without proper measurement, older people may expose to falls that can lead to more serious complications such as fractures and respiratory complications. Thus, those assessments were important to avoid hazard exposed to the older people, serious complications and for safe environment during treatment that involves older people.

There are several limitations of this systematic review study. Firstly, less study was reviewed that lead to lack of evidence to support the study. Secondly, there was lack of studies that include participants with LBP even there are relationship between posture abnormalities and falls among older people, and one article had poor quality of McMaster score [18]. The low score can affect the mean score of all articles that lead to low overall quality of the study. Further research on specific types of abnormal posture that related to falls among older people with LBP should be done to identify which type of postural abnormalities have higher tendency to falls. Perhaps more experimental studies towards posture and balance should be conducted among older people with LBP in the future.

4. CONCLUSION

Several types of abnormal posture reviewed in the study especially spinal and spino-pelvic alignment seem to contribute to greater postural instability, and thus to a higher risk of falls in older peoples with LBP. The findings of this study provide new evidence-based that beneficial to clinicians in their clinical settings to reduce the risk of falls among older people with LBP.

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